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ABSTRACT

A model of the teaching-learning environment, based on cognitive-constructivist theories of learning, is presented. The model consists of three dimensions. Dimension One (Opportunity for Constructivist Activity) represents the proportion of teaching-learning activity that is directed to encouraging self-reflection, mobilization of individual cognitive representations, and integration of new learning within existing understandings of the students. The second dimension (Affect) is the relative amount of affective support provided by the teacher including recognition of student accomplishment, generally positive perspectives on the learning enterprise and supportive statements as opposed to aversive statements. The third dimension (Pace) is the tempo of classroom activity as assessed by the rate of teacher discourse and time between teacher solicitation and student response. The three dimensions are arranged in a triangular graph (bounded by the three dimensions) that permits localization of a teaching-learning environment within the field of the graph. The rationale for the model predicts that student perceptions of satisfaction with the learning experience will increase as the characteristics of the lesson place it closer to the vertex of the model categorized as constructivist. We have assessed the predictive validity of the model by coding tape-recorded lessons from four classes with teachers who varied in style of teaching from more didactic toward constructivist. The lessons were mapped into the triangular field of coordinates based on the assessment of dimensions by three coders working independently (standard error of assessment = 0.04 to 0.06). We also obtained student perceptions of the lessons using a Likert-type device. The results of this study show that, as predicted by theory, lessons mapped closer to the constructivist vertex were rated more highly by the students for ease of understanding and positive emotional tone, compared to lessons that were more removed, in the triangular field, from the constructivist vertex. (Author)

A TRIPHASIC MODEL OF THE TEACHING-LEARNING ENVIRONMENT BASED ON CONSTRUCTIVIST PRINCIPLES

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A TRIPHASIC MODEL OF THE TEACHING-LEARNING ENVIRONMENT BASED ON CONSTRUCTIVIST PRINCIPLES

INTRODUCTION

Background

Recent advances in our understanding of human learning emphasize the importance of the role of the learner in constructing interpretations of experience rather than storing information in a rote manner (1- 7). These interpretations, comprehensively labeled cognitive-constructivist models, provide guidelines for creating teaching-learning environments that better complement the learner's inherent capacity to order experiences, generate self-regulatory activities, and coherently integrate information and skills into pre-existing cognitive structures. These experiences should be ordered in a way that are most pertinent to the learner's current state of readiness, and individualized or idiosyncratic way of learning. It is clear, however, that information processing can occur at various levels as shown on the continuum in Figure 1.

UCS		CS		Discriminative CS		Cognitive models		Constructivist models
In-born response conditioning	-------	Pavlovian-type conditioning	----	Skinnerian-type conditionsing	-----	Reception Learning information storage	---	Information processing analytical-generative

Fig. 1 A continuum of models from simple conditioning to higher order processing.

The constructivist pole of this continuum represents an idealized (though not impractical), and highly humanistic, view of learning that is in sharp contrast to the operant models and S-R conditioning paradigms that dominated the field in past decades. To achieve these ideals of higher order cognition as implied in constructivist theory, an appropriate learning environment is required that provides adequate support for constructivist learning activity including: 1. adequate opportunity for constructivist learning such as self-reflection and integration of learning within existing knowledge structures, 2. proper affective support to encourage individualized constructivist activity, and 3. appropriate pace of classroom activities to permit the individualized activity implied by constsructivist philosophy. We have devised a model of the teaching-learning environment (labeled a triphasic model) that incorporates these three aspects. We have used a three-dimensional triangular, phase diagram to express the interaction of these three components of teaching and learning as described below.

Rationale and Description of the Model

The model is shown in Figure 2 (page 7). Dimension One (Opportunity for Constructivist Activity) labeled r_c represents the proportion of teaching-learning activity that is directed to encouraging student self-reflection, mobilization of individual cognitive representations, and integration of new learning with existing understandings. The second dimension (Affect) labeled r_{af} is the relative amount of affective support provided by the teacher including recognition of student accomplishment, generally positive perspectives on the learning enterprise and supportive statements as opposed to aversive statements. The third dimension(Pace) labeled r_{pa} is the pace of the classroom activity as assessed by the rate of teacher discourse and time between teacher solicitation and student response. With respect to dimension two, it is important to realize that the scale represents the degree of aversiveness. Thus, the segment between 0 and +1.0 represents the amount of positive and supportive statements of the teacher, with + 1.0 being the most highly supportive, 0.0 being neutral. Positions on the other half of the scale represent increasing aversive states with -1.0 being most aversive. Within this three-dimensional field of the triangular model, some predictions are made about student response to the teaching-learning experience. The three vertices labeled Pa, C, and Pu represent extreme sets of conditions. Vertex Pa represents a learning environment where opportunity for self reflection and construction are low (r_c low), while punitiveness is low (r_{af}, low), and pace (r_{pa}) is high. Under these circumstances, the coordinates of the three dimensions define a point in the lower left-hand corner at vertex (Pa). This indicates that the teaching-learning environment is dominated by the rate of communication. In other words, among the three variables, pace is a major variable characterizing the context for learning. When opportunity for constructivist activity is high, ($r_c >$ 0.5), classroom affect is positive (r_{af} near +1.0), and pace is moderate (r_{pa} <0.5) then the coordinates define a point in the top vertex labeled C. This represents a highly supportive environment for constructivist learning, where the individual can process information at an appropriate rate for their particular level of thought, and in a supportive affective environment. If, however, the learning context is characterized by a highly aversive environment (r_{af} near -1.0), while constructivist opportunity is low (r_c low), and pace is moderate to slow ($r_{pa} < 0.5$), then the coordinates define a point in the lower, right-hand corner labeled Pu. This is a teaching-learning environment that is largely aversive and driven by negative affect. This should yield less rational information processing and more dependence on S-R type of encoding of information resulting in part from anxiety and negative affect engendered by an unsupportive environment that is slow in pace and low on constructivist motivation. A mid-point on all three dimensions defines a location in the middle of the field which would represent a moderate level of constructivist opportunity in a generally neutral to positive affective environment.

Based on this model, we predict that students will report the most favorable responses to lessons when the teaching-learning environment is categorized closest to vertex C. Less

favorable responses should be engendered when the teaching-learning environment is categorized near the base of the triangular field (vertices Pa or Pu). To test the applicability of the model and assess the validity of our predictions about student response a pilot study was done.

APPLICATIONS AND RESULTS

Pilot Study: Methodology

Tape-recorded records of six junior-high level mathematics classes were obtained in a culturally and socioeconomically diverse school. We asked the school to provide a sample of teachers who in their opinion represented different philosophies of teaching ranging from a more didactic to a more constructivist approach. We were not told, however, which category the teachers were in when we received the tapes. After the lesson was tape recorded, we asked the students in each classroom to complete a Likert-type scale (Chart 1) assessing their reaction to the lesson. Results from four of the six tapes, illustrating a range of teaching-learning environments, are presented here

To assess the lessons, relative to the dimensions of the triphasic model, three coders were trained in the definitions of the scales for the model and were asked to code each of the tape-recorded lessons to identify its location on each of the three dimensions. For dimension 1, the value on the dimension was determined by assessing the proportion of teacher statements that elicited information about student understandings of what they knew, how they explained what they knew, and provided new information in a way that built on the students' present understandings. For dimension 2, the number of supportive, neutral, or aversive teacher comments was determined and expressed as a proportion of total statements. If the number of supportive statements predominated, then the proportion was plotted between 0.0 and +1.0 on dimension 2. If the number of aversive statements predominated, then the proportion was plotted on the second half of the dimension from 0.0 to -1.0. The pace was scaled by determining the rate of communication, that is the number of statements per minute and the density of new ideas introduced per unit time (the number of new concept words introduced per minute). We devised a weighting scheme to combine the rate and density coefficients into a single score. After the three coders worked independently, we pooled their estimates and obtained a standard error of the mean as an expression of accuracy. The results of the intercoder ratings appear in Table 1.

TABLE 1 MEAN ESTIMATES (MN) & STANDARD ERRORS (SE) FOR THREE CODERS

Dim. 1 Constructivist Opportunity	r_c	Mn = 0.70	SE = 0.06
Dim. 2 Affect, positive or negative	r_{af}	Mn = 0.26	SE = 0.06
Dim. 3 Pace , rate of commun.	r_{pa}	Mn = 0.48	SE = 0.04

The coordinates of the three axes were used to define a space in the three dimensional field where the teaching-learning environment was located (Fig. 3, p. 6).

The mean scores for the Likert scales (max. score on the scale = 6.0) are reported for each lesson in Table 2 (p. 5), and as a numerical value in the circle identifying the position of the lesson within the field of the triphasic model (see Fig. 3).

TABLE 2 STATISTICS FOR THE FOUR LESSONS:

VALUES ON DIMENSIONS 1 TO 3 AND MEAN LIKERT SCORE

		Dim. 1 (r_c)	Dim. 2 (r_{af})	Dim.3 (r_{pa})	Likert Score
Lesson Mz 1	(A, Fig. 4)	0.78	0.25	0.40	5.1
Lesson Mz 2	(B, Fig. 4)	0.53	0.20	0.70	4.7
Lesson Ad	(C, Fig. 4)	0.0	0.27	0.60	4.0
Lesson Me	(D, Fig. 4)	0.10	0.05	0.35	4.2

[**See also Figure 3**]

WE WOULD LIKE TO KNOW YOUR OPINION ABOUT THIS LESSON.
THIS IS NOT A TEST. IT IS A WAY OF FINDING OUT YOUR OPINION ABOUT THE LESSON. PLEASE READ EACH STATEMENT BELOW. THEN READ THE WORDS ON THE LINE BELOW THE STATEMENT. PLACE AN X IN THE SPACE ON THE LINE THAT BEST REPRESENTS YOUR REACTION TO THE LESSON.

FOR EXAMPLE, SUPPOSE YOU WERE ASKED TO DECIDE HOW THE TEMPERATURE TODAY MADE YOU FEEL. PLACE AN X IN THE SPACE THAT BEST COMPLETES THE STATEMENT: THIS IS A SAMPLE.

THE TEMPERATURE TODAY MADE ME FEEL

Uncomfortable — Comfortable

If you were very uncomfortable today, you would place an X on the line near the end marked uncomfortable. If the temperature made you feel very comfortable today, your X would be placed very near the word comfortable. Please make an X in the place that is appropriate.

PLEASE COMPLETE EACH OF THE FOLLOWING STATEMENTS
ABOUT THE LESSON YOU HAVE HAD THIS PERIOD.

---

1. **DURING THIS LESSON, I WAS ABLE TO KEEP UP**

Very Little — Very Well

2. **I FELT THAT THIS LESSON INTERESTED ME**

Very Little — Very Much

3. **THIS LESSON WAS RELATED TO SOMETHING I LEARNED BEFORE**

Very Little — Very Much

4. **DURING THIS LESSON, I FELT**

Uncomfortable — Comfortable

Chart 1 Likert Scale administered to the students in each class

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Pilot Study: Results

As Shown in Figure 3, those lessons that were mapped nearer the apex of the triphasic model generated more positive student responses as shown by the mean Likert scale score than those lessons with a lower position in the field of the model. The Likert items as shown in Chart 1 concerned the students' perceptions of the ease of understanding of the lesson, their sense of comfortableness with the lesson, and their assessment of the relevance of current lesson content to prior learning. The pilot study on the whole tends to support the theoretical predictions of the model.

DISCUSSION AND SIGNIFICANCE

Current concepts in constructivist philosophy are beginning to be integrated into generalized models of teaching and learning in a way that will permit us to make empirical investigations of theoretical predictions, and to establish comprehensive explanatory models that may enhance teacher education. This paper presents a model that provides a graphic interpretation of some dimensions of constructivist philosophy consistent with current cognitive psychology and psycho-social theories of classroom organization. The triphasic model is based on the assumption that learning environments vary in their supportiveness for constructivist activity as conceptualized in Fig. 1. The three dimensions of the model (pace, affect, and opportunity for constructivist activity) have been selected as three contributory variables that may influence the quality of student learning. For constructivist learning to be effective, there must be a sufficient opportunity for students to mobilize their thoughts, relate new experiences to prior learning and generate guiding principles that help them monitor and control their own learning. When the lesson pace is too rapid, these individualized learning processes may be interdicted leading to more rote forms of information encoding. A reasonable level of positive affect is likely to support student self evaluation, exploration and application of idiosyncratic learning strategies consistent with a constsructivist philosophy of teaching and learning. This is likely to be further supported if the learning environment provides encouragement for constructivist strategies of learning. Hence, we think that the three dimensions presented in the triphasic model represent fundamental qualities of the learning environment that are significant in promoting a constructivist mode of learning. Philosophically, it is important to note that we do not conceive of this as a model of teacher behavior, but rather a model of the learning environment. The intent is not to evaluate teaching but to provide a way of representing the degree of supportiveness of a learning environment for constructivist learning activity. It is interesting to note that the lessons labeled as Mz1 and Mz2 were taught by the same teacher, but differed in composition as shown by the position within the triphasic field and by the mean Likert scale response of the students. In addition to providing a tool for visualization of the effects of a learning environment on student perceptions of the quality of the experience, the triphasic model may be a useful teacher-education tool for encouraging creative discussions of what constructivist philosophy means in science

teaching and how the teaching-learning environment can be arranged to maximize constructivist ideals of science education.

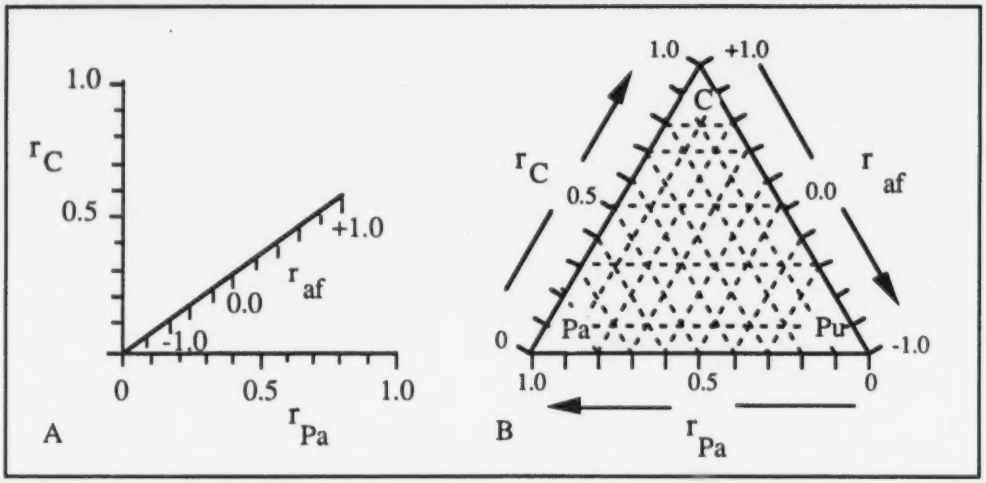

Fig. 2a The three dimensions of the model shown as a set of Cartesian axes (A) or in a triangular triphasic model (B) as used for mapping the position of a learning environment within the field of the three dimensions (see text for details). The Cartesian set of axes can be used to represent the geometric position of different lessons relative to the three dimensions (Fig. 2b). Each lesson is assigned a point in space determined by the three coordinates. The triphasic field model is used typically to map the position of an individual lesson.

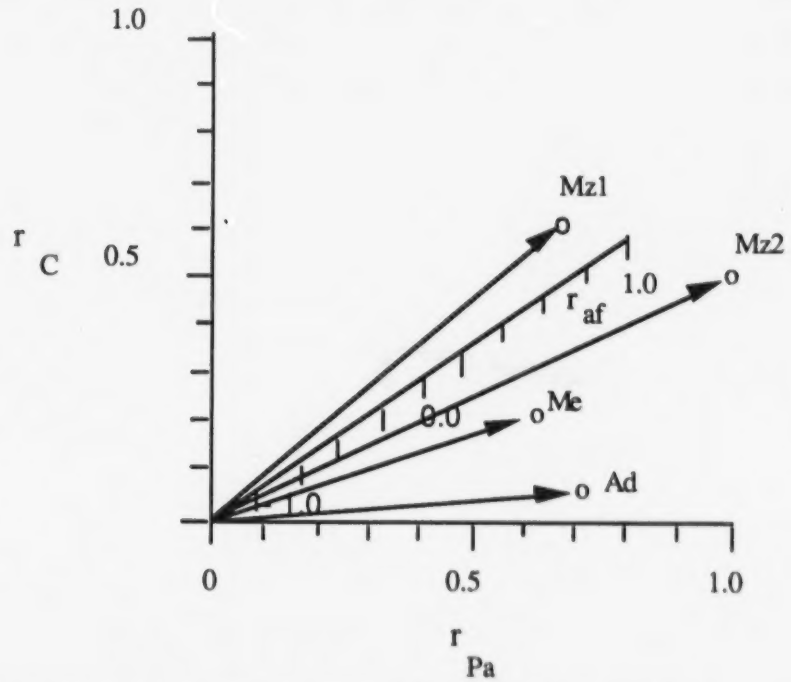

Fig. 2b Plot of the coordinates for lessons Mz1, Mz2. Me, and Ad.

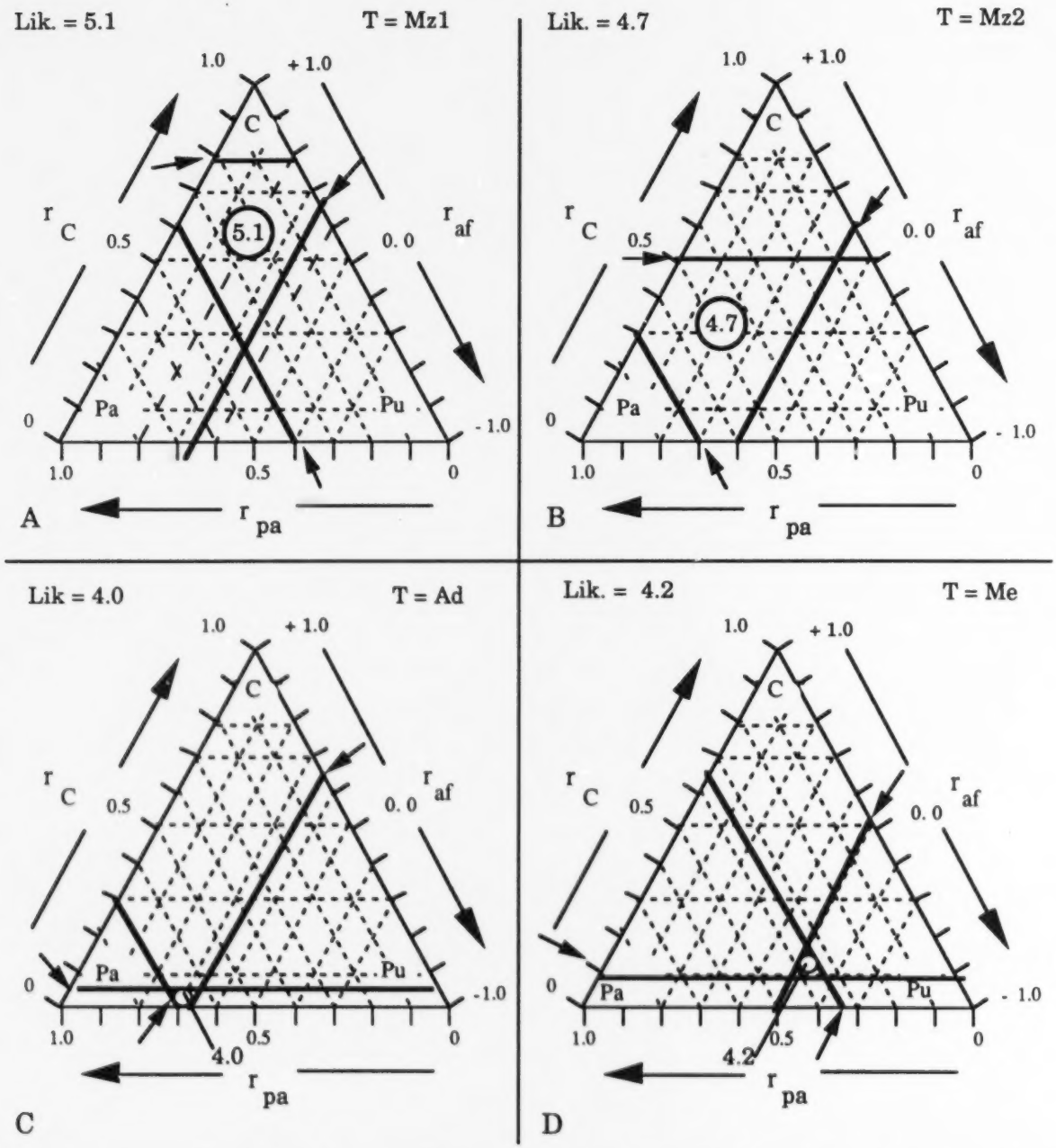

Fig. 3 A comparison of four lessons varying in position within the field of the triphasic model. Lesson A (Likert mean value = 5.1) is clearly higher on all dimensions than lessons B to D. Among these lessons, lessson B is moderate in mean Likert value (4.7) and is sited in the lower-middle part of the field. Lesson C is the lowest in mean Likert value (4.0) and is at the very base of the field. Lik = Likert mean value, T = code for class.

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